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FEATURE ARTICLES

FEATURE ARTICLES
(Continued)

SOVIET UNION

1. Soviets Enlarging Planetary Institute for Space Research:

In support of the Soviet space program, Kharkov University is enlarging its Planetary Institute, according to recent reports from the USSR. A large new dome which will house a specially designed planetary telescope is under construction near the town of Chuguyev (49 50N, 30 39E), southeast of Kharkov. The new dome will be surrounded by laboratory and service buildings and living quarters for personnel. The Soviets claim that this is the world's first planetary institute.

Plans for the institute became known in February 1959 when a preliminary project that would eventually come under the institute was set up at the Astronomical Observatory of Kharkov University imeni Gorkiy. At that time the objectives of the institute were given as "research on the most outstanding problems of physical planetary study and the observation of artificial earth satellites and artificial planets." Recent reports have repeated these objectives and have indicated that investigations will also be made of the sun and moon, and of the magnetic fields of the earth and planets.

The head of the institute is Academician N. P. Barabashov, the leading Soviet planetary astronomer and a member of the Interagency Commission for Interplanetary Communications (ICIC), the coordinating agency for the Soviet scientific space effort. As a member of the ICIC, Barabashov is a leading scientific figure and probably heads the Soviet scientific space program for planetary investigations. For some time Barabashov has been director of Kharkov Astronomical Observatory and chairman of the Commission on the Study of the Moon and Planets of the Astronomical Council of the Academy of Sciences. In 1960, he was reported ill of lung cancer, and he did not appear at the Symposium on the Moon in Leningrad in December 1960, but recent news dispatches from the USSR continue to mention him as director of the Kharkov Planetary Institute and quote him as saying that the work carried out there will be of great assistance to astronauts in landing their interplanetary ships on the planets.

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The expansion of the Planetary Institute is another example of the Soviets' effort to back up their space program with adequate ground research facilities and programs. The institute will probably be closely associated with the scientific investigations of any future Soviet planetary vehicles and possibly of any lunar vehicles.

Other groups with strong lunar and planetary support capabilities exist in Moscow and Leningrad. The most important personalities in these are located at the Main Astronomical Observatory at Pulkovo. They are A.V. Markov, the leading lunar specialist on the ICIC, and A.A. Mikhaylov, chairman of the Astronomical Council, who has taken a strong personal interest in the scientific equipment and missions of the Soviet lunar vehicles. (CONFIDENTIAL)

Sources: Komsomolskoye Znamya, Kiev, 16 Sep 61, and Rabochaya Gazeta, Moscow, 14 Sep 61, UNCL

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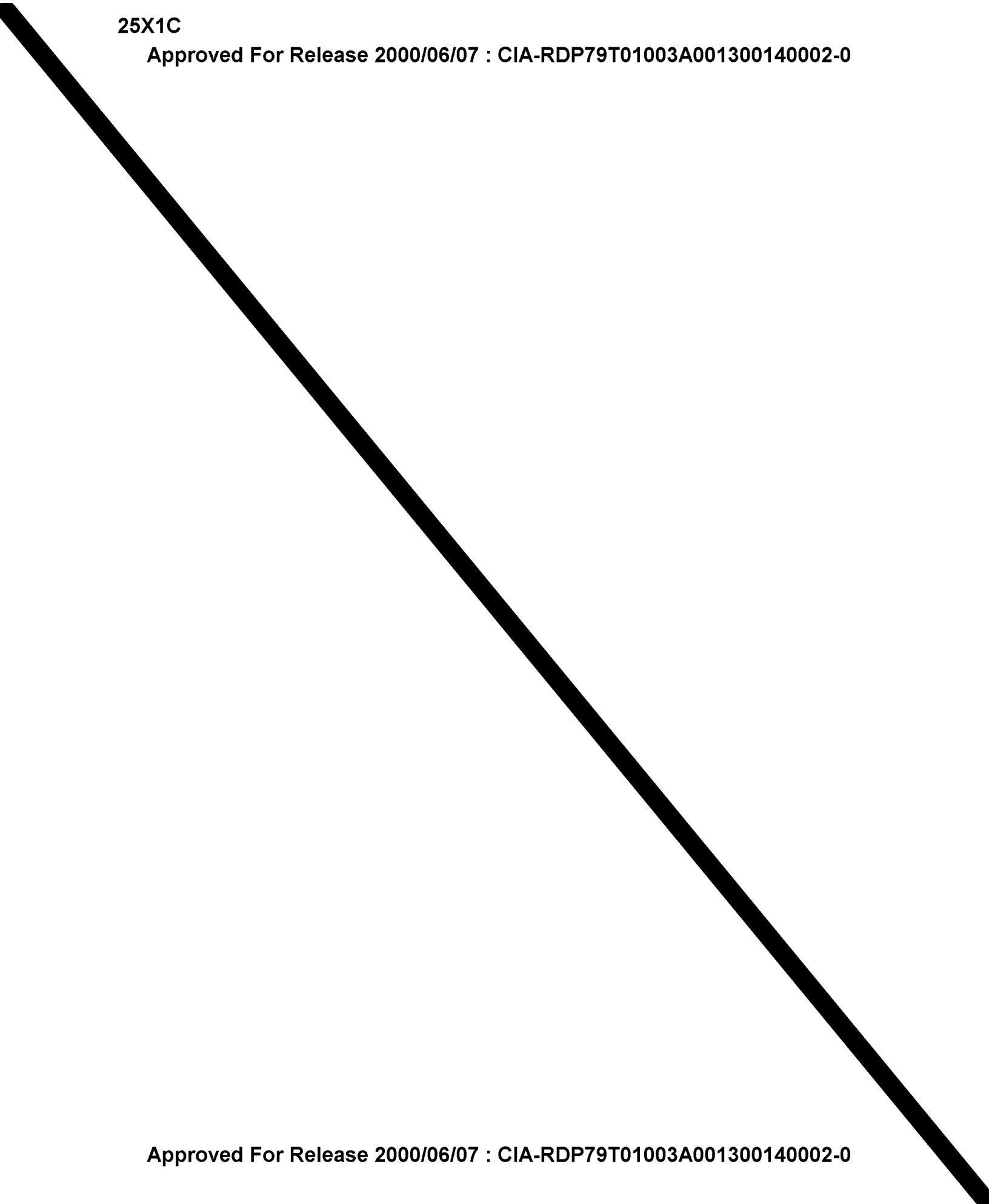

3, Possible Soviet Development of Beryllium as an Additive to Rocket Fuels:

During the International Conference on the Metallurgy of Beryllium, held from 16 to 18 October 1961 in London, the Soviet delegates talked in terms of several hundred kilograms of beryllium for fabrication and mentioned the use of beryllium as an additive to rocket fuels. According to the Soviets, their work on beryllium is only for research and development. The addition of 15 percent beryllium powder to liquid oxygen and liquid hydrogen in a bipropellant system, according to mathematical calculations, would raise the theoretical specific impulse (ISP) from 391 seconds to about 450 seconds at sea level. In general, a high-energy (450 sea-level ISP) stage in place of the lightweight third stage in the Soviet space vehicle would more than double the payload capability.

If 15 percent beryllium were used to replace aluminum in a solid propellant composed of ammonium perchlorate and hydrocarbon binder, the theoretical specific impulse increases from 266 seconds to 285 seconds at sea level. A rocket motor using this propellant is being actively tested in the United States for the fourth stage of the Scout, a space research vehicle. At the present time, no other U.S. solid propellant has such a high specific impulse. The increase in performance resulting from the addition of beryllium would offer an advantage for deep-space missions, or for carrying extremely heavy payloads in advanced weapon systems. Beryllium, however, must be restricted to upper stages because of its extreme toxicity. The Scout fourth stage will require 100 pounds of beryllium.

This is the first indication of Soviet interest in beryllium as an additive and may indicate an early research program aimed at increasing the performance of future upper stages. (SECRET/NOFORN/[redacted] 25X1C
[redacted] 25X1C

Source: CIA, 6 Nov 61, CONFIDENTIAL/NOFORN/[redacted] 25X1C
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5. Soviet Steel Suitable for Deep-Diving Submarines:

The Soviets have evidently developed a new steel for ship construction similar to the U.S. Navy's HY-80 steel, which has a yield strength of 80,000 pounds per square inch. An article in the Soviet periodical Welding Production (Svarochoye Proizvodstvo) concerns the development of new electrodes, designated EA981/15, for welding "high-strength, medium-alloyed steels of the type 15Kh2N4MDA." These steels, it says, are being used in a number of "welded structures." Additional information in the article that the Izhorskiy Zavod,* a plant closely associated with shipbuilding steel production, participated in the work and that specimen welds were tested for intergranular corrosion in sea water suggest that this steel is used in shipbuilding. The article further discloses that the sample welded joints were all made in plate which "had undergone the entire cycle of heat treatment (quenching and tempering)," that the weld metal (and hence also the steel) has a yield strength of from 71,000 to 85,000 pounds per square inch, and that this steel has a high resistance to brittle fracture. The quenching and tempering of such steels gives them high resistance to brittle fracture at low temperatures, a phenomenon which was found to be the cause of the breaking in two of many ships during World War II. The use of such high-strength, tough steels in submarine construction permits lighter hulls with deeper diving capability and also increased resistance to depth charge attacks.

The most interesting aspects of these new Soviet steels are the amounts of the important elements in their chemical composition, which the designation "15Kh2N4MDA" indicates to be 15 percent carbon, approximately 2 percent chromium, approximately 4 percent nickel, and 0.5 to 1.0 percent of molybdenum and of copper. The "A" in the designation stands for "high-quality." These elements are needed in a steel in order for it to respond to the quenching and tempering heat treatment which gives it, in addition to its high strength, its high brittle-fracture resistance. Larger amounts of these elements are needed as the thickness of the plate increases. The amounts of the alloying elements allowed by the Soviet designation for the steels of type 15Kh2N4MDA are suitable for plates having thicknesses of up to 4 inches.

*It was subordinate to the Ministry of the Shipbuilding Industry until 1957, and may still be subordinate to the State Committee for Shipbuilding.

Fabrication of submarine hulls utilizing this class of steel plate in thicknesses of 2 to 4 inches would permit diving depths comparable to those achieved and projected for U.S. submarines. Although there is at present no indication of Soviet use of this steel in submarine construction, it undoubtedly was developed with this application in mind. (CONFIDENTIAL)

Source: Svarochoye Proizvodstvo, 1961 UNCL

6. Emphasis Within Scientific Fields in Academy of Sciences, USSR, Apparently Unchanged:

As usual after a Congress of the Communist Party of the Soviet Union, various parts of the Academy of Sciences, USSR, have examined their substantive programs to confirm that these are in line with positions taken at the Congress. The examinations conducted since the XXII Party Congress from 17 to 31 October 1961 resulted in no significant changes in the scientific and technical programs which were in progress before the Congress convened, at least insofar as such programs were reflected in speeches at the June 1961 All-Union Conference of Scientific Workers and in the draft program of the Communist Party published on 30 July 1961. This lack of change of emphasis in scientific fields since the Congress convened has been reflected in a report in November by M.V. Keldysh, president of the Academy, in which he stated that research emphasis would remain on energy conversion, solid state physics, space flight, and various other recognized scientific disciplines, including cybernetics, electronics, biology, nuclear physics, and the physics of high molecular weight compounds. Other academicians have elaborated on a few of these fields, but without significantly altering the previous theses. Academician Anatoly Blagonravov reported in November that the problems in Soviet technical sciences would in the near future relate, as before, to such fields as power engineering, metallurgy, and mining engineering. (CONFIDENTIAL)

Source: FBIS, 16 and 17 Nov 61, OFFICIAL USE ONLY

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7. New Information on Probable Soviet Chemical Warfare Plant:

[redacted] Plant 91 at Beketovka near Stalingrad was active in the production of CW material in 1956. This recently acquired information reflects a probable continuing CW activity that began during World War II and is probably still in progress.

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[redacted] Plant 91 was a closely guarded military chemical plant and that it had been expanded several times with new buildings. This growth is substantiated [redacted] CW toxic agent production and chemical agent filling of bombs is indicated [redacted] Production of phosphorus, which is a CW incendiary agent, and of chlorine was reported; that of chloride of lime, used as a CW decontaminating agent, is inferred [redacted]

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Previous reports placed Plant 91 as a producer of the older standard agents, such as mustard, and the site of the Soviet pilot plant effort on sarin (GB). A new plant for production of organophosphorus insecticides, and believed to be convertible to manufacture of V agents, has been built in the area. Although not confirmed, it is possible that this plant, because of the chemicals used and the product manufactured, is connected with or is part of Plant 91. Phosphorus and chlorine production at Plant 91 is considered established.

Possible development of a CW production center in the Stalingrad-Beketovka area is suggested by correlation of the available information. As noted above, Plant 91 appears active in CW production and has a record of pilot plant effort. Recently, a branch of the Institute of Elemental Organic Compounds was established at Stalingrad (see SID 61-13, 26 Jun 61, SECRET/NOFORN). The Institute has been connected with nerve agents and the Soviet CW effort through the work of M.I. Kabachnik and I.L. Knunyants. Laboratories concerned with organophsophorus compounds and with technology are two of the five that comprise this branch. In a cooperative effort with Plant 91, the organophosphorus laboratory could provide support, such as study of reaction mechanisms and identification of by-products, that is beyond the control function. The technology laboratory, in cooperation with operating plant personnel, could work out process and equipment details required in production operation. (CONFIDENTIAL/NOFORN/[redacted]

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Source: CIA, 25 Sep 61, CONFIDENTIAL/NOFORN [redacted]
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FEATURE ARTICLES

SOVIET GEOPHYSICAL RESEARCH POSSIBLE DISGUISE FOR EARTH-CURRENT COMMUNICATIONS DEVELOPMENT

Summary

Several facets of Soviet terrestrial geophysical research suggest that the USSR has an earth-current communications (ECC) program. ECC is a term applied to the transmission, for communication purposes, of electrical currents or radio waves whose paths are partly or entirely through rocks or water. Anti-jamming and security features, communication with submerged submarines without exposed antennas, and particularly "hardening" are some of the desirable features of ECC that would prompt the Soviet Union to develop, if technically feasible, an ECC system.

Soviet electromagnetic prospecting literature suggestive of ECC work in 1953, followed by an increase in the number and a wider distribution of earth-current stations, and more recently Soviet statements on deep wells and tunnels point toward the existence of a Soviet ECC program. The scientific or economic aspects of earth-current stations, deep drilling, and studies of the earth's crust and marine electrical currents are a suitable cover under which the Soviets could conduct an ECC development program.

Discussion

Electrical Prospecting--Electrical prospecting, including electromagnetic and telluromagnetic methods, and earth-current communications share some common problems. Both deal with the transmission and reception of electrical or electromagnetic energy through rocks. Thus Soviet electrical prospecting personnel would probably be involved in any Soviet ECC program. These personnel, however, probably would not be permitted to publish the results of any ECC work. They could, after some extrapolation, apply their ECC results to models or theories in electrical prospecting and thereby could publish in prospecting literature.

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Soviet reports of 1953 and 1954, apparently of a special nature, dealt with electrical prospecting. The first known reference to the 1953 report, however, was in 1960 when V.N. Nikitina mentioned in a footnote a joint work by A.N. Tikhonov and D.N. Shakhsuvarov, "The Application of Electromagnetic Fields from Radio Stations to Geophysical Exploration," Report, Funds of the Geophysical Institute, Academy of Sciences, USSR. The use of the term "funds" (fondy) in this way is seldom seen and its significance is not clear. In 1954, a paper with the same title and by the same authors as referenced by Dmitriyev in 1959 and Nikitina in 1960 appeared in Works of the Geophysical Institute, No. 9A, an issue not known to be available outside the USSR. All available issues of this journal carry only a number to designate the issue. Other issues of this journal that are unavailable but known through Soviet references to them and which use a letter and number combination are concerned with subjects suspected of having a security classification. The fact that the paper was published under these conditions and that the concept of using signals from radio broadcasting stations in geophysical exploration was not new in 1953 suggest that the work may have contained classified results on the propagation of radio signals through the earth.

Tikhonov is the leading Soviet geophysicist in geoelectricity. He has authored many articles on electrical prospecting and a book on mathematical physics. In view of his stature, it is somewhat surprising that he apparently has not attended international meetings outside the USSR. He is believed to have been and possibly still is the supervisor of V.A. Troitskaya, an earth-current specialist who has attended many international meetings. Tikhonov's background, experience, and position would logically dictate that he be included in any Soviet ECC program.

Additional Soviet research which may reflect ECC work was referred to in 1959 and 1960. Nikitina, in the treatment in 1960 of a model for electrical prospecting, singled out the case of radio-sounding of rock formations between boreholes and mines, a reasonable prospecting problem, but one having overtones of hardened communications. Again she footnoted, by an unusual type of reference, her 1956 work on the same problem as Report, Part I, Funds of the Institute of the Physics of the Earth, Academy of Sciences, USSR. Berdichevskiy and Bryunelli in 1959 referred to a work by S.M. Sheynmann, "The Possibility of Utilization of the Fields of Telluric Currents

and Distant Radio Stations for Geological Prospecting," Report on the Work of the All-Union Institute of Prospecting Techniques (VITR), Funds of the VITR, 1957. Sheynmann later published a paper by the same title in a prospecting journal.

Deep Drill Holes and Tunnels--In ECC, two wave paths are of interest: (1) a ground wave traveling from a buried transmitting antenna up to and along the earth's surface and then down to a buried receiving antenna; and (2) a direct wave traveling a straight line subsurface path between buried antennas. The ground wave is less secure and more subject to jamming against surface-mounted countermeasures but undergoes less attenuation than the direct wave. The ideal situation is one in which the antennas are located in deep wells or mine tunnels and the energy is propagated through a rock wave guide--a rock layer having certain differences in electrical properties from those of adjacent layers. It is in this context that recent announcements by the Soviets of tentative plans to drill five deep holes may have added significance over and above the many scientific and economic potentialities of the program and the propaganda effect to be realized by the Soviets if they should reach the Moho before the United States.

The layered structure of the earth's crust results in formations which can serve as buried waveguides. Geological and geophysical studies will assist in delineating promising areas with the necessary qualifications. All areas of the Soviet deep tests have been studied in considerable geological and geophysical detail for economic or scientific interests. At some stage in ECC development, deep drill holes or deep mines or tunnels would be needed to evaluate experimentally the feasibility of underground communications. The Soviet deep holes might thus provide an excellent opportunity to investigate subsurface communications possibilities of a thick and varied geological cross section.

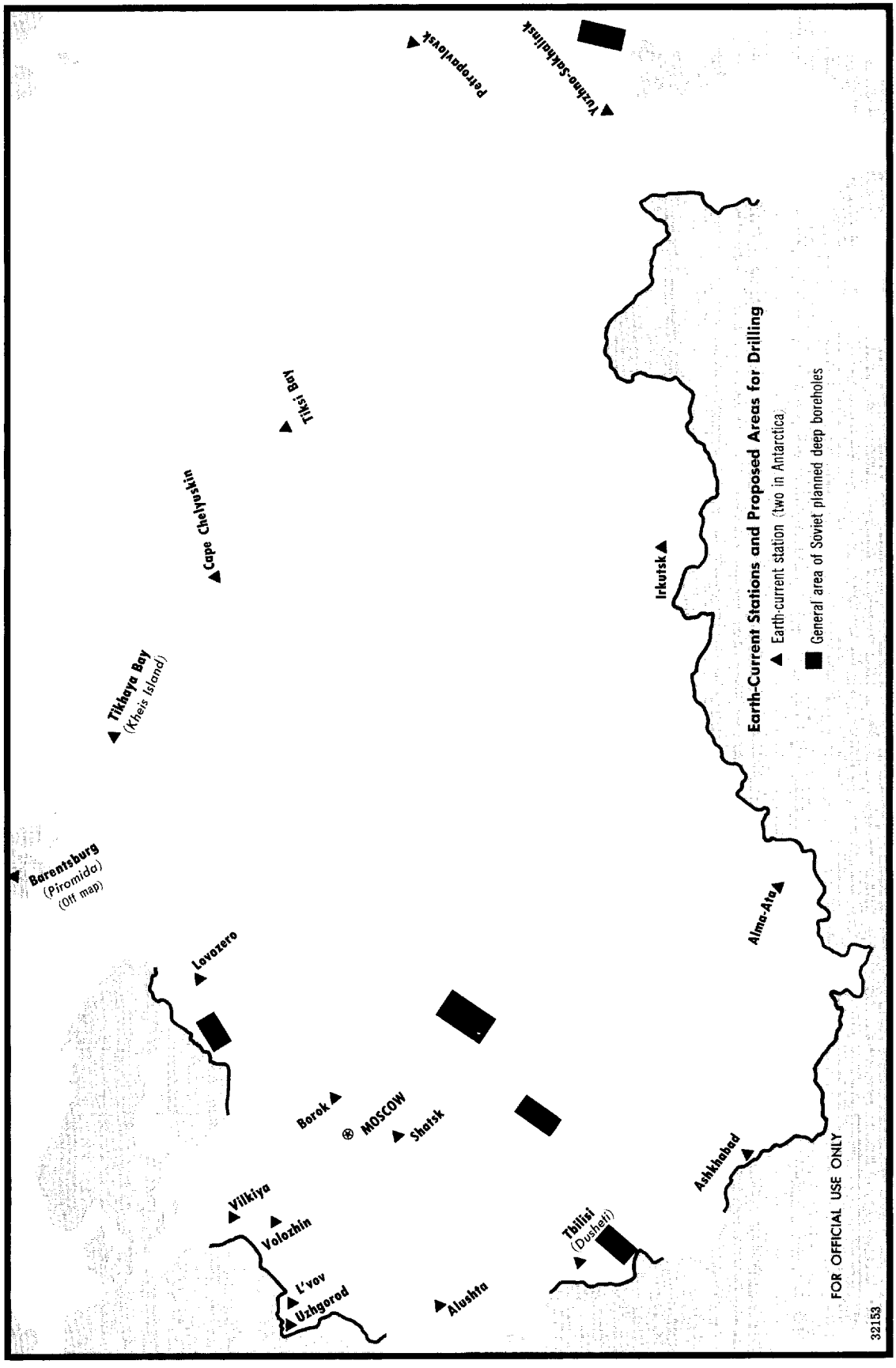
M. Keldysh, president of the Academy of Sciences, USSR, recently stated at a high-level scientific meeting that it "was necessary, for instance, to lower into the depths of the earth a complex scientific station similar to those installed in spaceships and sputniks." This statement is significant for at least two reasons. First, it most likely represents an official attitude and probably is a precursor of an intensified Soviet program to study the crust of the earth. To be recalled are statements attributed to A.N. Nesmeyanov,

former president of the Academy of Sciences, USSR, in 1953 which set the stage for Soviet earth satellites some four years before Sputnik I. Second, the lowering of a complex station could include the lowering of transmitters and/or receivers trailing long wire antennas to study underground communications. Keldysh's statement apparently opened the way for statements by other Soviets, who, also borrowing from space terminology, coined terms such as "intra-terrestrial vehicle."

A system of vertical and inclined shafts was suggested at a Soviet meeting announcing the deep boreholes as a means to permit direct study by man at great depths to alleviate the shortcomings associated with remotely controlled instrumental probing. Although no official Soviet statements have been noted on the subject of deep tunnels, the topic is one that might arise in a program of hardened constructions and affiliated hardened communications.

Earth-current Stations--The network of Soviet earth-current stations could either be a part of or used in the development of a hardened ECC net for purposes such as alert and execute types of commands, or in the case of stations near coastal regions, for communication with submerged submarines. In general, these stations are distributed around the perimeter of the Soviet Union, but with some concentration in the western part of the country. Such a distribution may reflect Soviet desires to study natural phenomena over the widest possible ranges of latitude and longitude. Nevertheless, the number and distribution of the stations have given rise to attempts in the West to explain these stations on the basis of reasons other than (1) "science for the sake of science" and (2) Soviet capability for detecting nuclear explosions.* Presumably, implicit in possible explanations are concepts such as using the natural earth currents as a carrier of a signal impressed upon them or using the stations for transmitters and receivers of artificially generated energy. Feasibility of the former concept is not known to have been demonstrated. The latter concept bears some similarity to methods being considered in the United States.

*V.A. Troitskaya, Effects in Earth Currents Caused by High-Altitude Atomic Explosions, Bulletin, Academy of Sciences, USSR, Geophysics Series, no. 9, 1960.



No finite model analysis of Soviet earth-current stations as an ECC net can be made at present because of lack of information about the stations, such as (1) geometry of wires which might serve as antennas, (2) location of wires above, on, or below the ground and vertical separation from the surface, (3) evidence of wires in buried cavities, (4) evidence of powerful generators, (5) geological structure of and between station locations, and (6) ground conductivity data. Relative to ground conductivity, DOSAAF (a volunteer society whose purpose is to assist and support Soviet armed forces) and the USSR Minister of Communications in 1958 requested the support of amateur radio operators in the Soviet Union in the preparation of a ground conductivity map of the USSR. This action can be explained on the basis of normal radio broadcasting needs but nevertheless would result in data of value to ECC using ground waves.

A variation of ECC is one in which one station is on land and the other is at sea. Four of the announced deep Soviet tests are in areas adjacent to seas, presenting excellent opportunities to investigate communication possibilities between deep shore stations and submerged submarines. In this connection, the Soviets have carried out electrical prospecting experiments at sea using a feeding dipole 1.5 kilometer in length and a mobile receiving dipole 300 meters long towed by a boat; have measured natural electric currents at various depths in the northeastern part of the Black Sea, the northwestern part of the Pacific Ocean, and the Barents Sea; and have conducted theoretical studies on variations of marine electrical currents in the case of a water layer overlying deep, well-conducting rock layers.

Whatever their purposes, the Soviet earth-current stations are providing data that can be used to study natural noise at extremely low frequencies and to determine "windows"--regions of least noise--in the earth-current spectrum, data of value in the development of an ECC system. (CONFIDENTIAL)

SOVIET RESEARCH APPLICABLE TO DEVELOPMENT OF CHEMICAL WARFARE INCAPACITATING AGENTS*

Conclusions

The USSR could have an incapacitating agent available for limited field use by 1965, dependent on the development of munitions for satisfactory delivery and the ability to manufacture such an agent. Because of the limitations of their chemical industry, the Soviets may find it expedient or necessary to adopt a less effective agent than would otherwise be possible.

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On the basis of Soviet research, there is evidence that any Soviet CW incapacitating agent developed will probably act on the central nervous system, [redacted] By interference with neuromuscular transmission, effects could range from hypotension to paralysis, and may include mental aberration.

25X2□ Based on U.S. experience and published Soviet work, a postulated new 25X2□
Soviet incapacitating agent [redacted]

Soviet chemists have probably synthesized two related experimental CW incapacitating agents now under investigation by the West. One of these is the most effective compound of its type found to date and is receiving serious consideration as a Western candidate agent. The Soviet research leading to this development, accomplished in 1957-58 at the latest, indicates that the USSR may be abreast of the West in the development of an agent of this specified type.

Summary

There are indications that the USSR has a CW incapacitating agent at a stage of development where it could be available for limited use by 1965. Nevertheless, other factors will influence the actual adoption of the agent by the Soviet military forces. These are Soviet military concepts, the development of satisfactory munitions for delivery, and the ability of the Soviet chemical industry to manufacture the compound.

*Reprint of Conclusions and Summary of OSI-SR/61-42, 15 Nov 61, SECRET/NOFORN [redacted] 25X1C

25X2

A definite emphasis on compounds affecting the central nervous system is found in Soviet research on physiologically active compounds. Although most of this research has medical objectives, without stated CW goals, some of it is applicable to CW objectives. [redacted]

25X2 [redacted] By interference with neuromuscular transmission, effects ranging from hypotension to paralysis and even to death result. Some of the compounds affect the mind. The nature of this research is consistent with the statement by Major General Yu. V. Drugov that research in this field had been conducted with military objectives since 1956. S.V. Anichkov and V.V. Zakusov, who hold military rank in addition to academician status, have also indicated special interest [redacted]

25X2 [redacted]

25X2 [redacted]

M.V. Rubtsov, an eminent Soviet chemist whose areas of research interest have possible CW significance, has synthesized [redacted]

25X2 [redacted] and M.D. Mashkovskiy, a noted Soviet pharmacologist

25X2 who has worked with many compounds of possible CW relationship, has investigated their pharmacological effect. The Rubtsov syntheses probably were accomplished in late 1957. While the compounds on which he published

25X2 have no CW significance, [redacted]

25X2 [redacted] Because both Rubtsov and Mashkovskiy, who work together at the All-Union Research Institute of Chemistry and Pharmacology imeni S. Ordzhonikidze, have

25X2 given much attention to [redacted] they possess the necessary background of interest and knowledge to make such substitutions. Although no such research has been published, the significant compounds probably have been made and tested for their physiological effects, and Soviet knowledge for their properties may be assumed.

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T.A. Melnikova also [redacted] probably in 1958. Although this compound was developed as a pharmaceutical, with minor changes in structure, [redacted] 25X2

[redacted]

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SOVIET RADIOASTRONOMY ANTENNA RESEARCH AND DEVELOPMENT*

Conclusions

The Soviets have attained a high degree of competence in basic research, development, and technology associated with radioastronomy antenna systems. New and improved types of antennas have been developed and placed in operation during the last few years. Soviet technology embraces both radio receiving techniques, which are used to study solar, galactic, and extra-galactic radio emissions, and radio echo or radar techniques, which are used for the investigation of various aspects of the sun, moon, planets, and meteors, as well as the earth's upper atmosphere.

The utilization of at least 143 basic antennas at 46 known radioastronomy sites located chiefly in the European and Caucasian areas of the USSR is evidence of a radioastronomy antenna development program probably exceeding that of the United States in the magnitude of effort.

Soviet research and development have resulted in an impressive array of radioastronomy antenna systems, including several that are among the principal radiotelescopes of the world. Soviet antennas are noted for their characteristics of narrow beamwidth or angular resolution, high gain, steerability, wide-band operation, and wide aperture. Outstanding are: (a) the 490-foot long, mechanically steerable, segmented plate reflector at Pulkovo that is capable of resolving cosmic sources with one of the narrowest beams ever achieved; (b) the 72-foot, fully steerable, parabolic reflector at Serpukhov, which is the most precise, high-gain antenna in existence for working down to millimeter wavelengths; and (c) a Mills cross under construction at Serpukhov, which will be the world's largest antenna and will have a capability to receive and resolve radio emissions from galactic and extragalactic sources beyond anything achieved so far.

In addition to the fundamental science aspects of radioastronomy, Soviet radioastronomy antennas have been, and will be, used in research associated with space vehicle communications and tracking.

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*Reprint of Conclusions and Summary of OSI-SR/61-41, 7 November 1961, SECRET/NOFORN/[redacted]

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The development technology associated with Soviet radioastronomy antennas and related transmitting and receiving equipment is probably being used to give support to anti-ballistic missile military programs and to the development of radio and radar intercept techniques.

Summary

The Soviets are conducting an expanding program on research and development of radioastronomy antenna systems. They have at least 46 Soviet radioastronomy stations, many of which are affiliated with optical observatories, where a variety of new, old, and modified antennas are used. These are located chiefly in the European and Caucasian areas of the USSR and utilize a minimum of 143 basic antennas. The United States has 36 comparable sites, including sites abroad, utilizing 59 antennas, many of which are associated with space and missile activities. Although the figures may not be directly comparable, they indicate that the Soviet program is quite large and probably exceeds that of the United States in terms of effort. New sites are being constructed at Riga, at Serpukhov south of Moscow, at Alma-Ata, at Loparskaya near Murmansk, and at Stalingrad. Soviet research and development on new and improved antenna systems is being conducted under such outstanding scientists as V.V. Vitkevich of the Physics Institute, Academy of Sciences, USSR, V.S. Troitskiy of the Scientific Research Radio Physics Institute of the Gorkiy University, and S.E. Khaykin of the Main Astronomical Observatory, Academy of Sciences, USSR. Although all aspects of radioastronomy are being exploited, most of the Soviet work has been associated with the moon and the sun.

The Soviets are utilizing radio echo, or radar, principles to augment the passive or receiving aspects of radio emissions from celestial sources. This new discipline, called radar astronomy, has been used in studies of the planet Venus, the Sun, the Moon, the upper atmosphere, the ionosphere, and of meteors. Radar astronomy antennas, some of which are modified military radars, are known to exist at 15 radioastronomy sites in the USSR. The research is directed toward improving meteor-burst communications and acquiring additional knowledge of the upper atmosphere and ionosphere and its communications implications, both terrestrial and in space. The

sophisticated antennas and related equipment have many applications in missile, satellite, and nuclear detection systems. Versatile and well-designed antennas at Gorkiy Scientific Research Institute of Radiophysics have resulted in outstanding contributions to radar astronomy research.

Planar arrays and continuous paraboloidal reflectors are the basic types of antennas that have been developed for radioastronomy research. The Soviet development of planar arrays appears to be an outgrowth of earlier antenna designs for the extensive shortwave communications systems in the USSR. Paraboloidal reflectors are up to 102 feet in diameter, but most are less than 30 feet. In size, none of these is comparable to the larger antennas in existence and currently being developed in the West. However plans reportedly are being prepared for a 262-foot fully steerable parabolic dish. The Soviet research and development in wide-band techniques is also reflected in many radioastronomy antennas.

USSR parabolic reflectors are mostly the types and sizes common to radar systems. Since 1955, however, the Soviets have focused their research and development resources on larger reflecting-type antennas. In 1956, at Pulkovo near Leningrad, the Soviets completed a new type of parabolic strip reflector 490 feet long made up of segmented plates that has one of the narrowest beamwidths in the centimetric region ever achieved. In 1957, they constructed an accurately surfaced 102-foot-diameter fixed earth-bowl antenna at the Crimean Radioastronomy Station. In 1958, they operated the first of four planned high-precision, 72-foot-diameter, fully steerable parabolic dishes at Serpukhov, near Moscow. Radioastronomy research in the millimeter range of the radio spectrum now is underway as a result of this precision-made antenna. Their largest operational antenna, which operates at meter wavelengths is an interferometer composed of four cylindrical parabolic antennas varying from 50 by 175 feet to 60 by 350 feet, located at the Byurakan Astrophysical Observatory near the Turkish border. The present complex probably was completed in 1959. The configuration will be increased to seven antennas at a later date. A very large Mills cross antenna, 3,300 feet by 3,300 feet, employing a cylindrical parabolid reflector with a dipole line feed, is nearing completion at Serpukhov, south of Moscow. On completion it will probably be the largest antenna and the most versatile Mills cross in existence. This antenna and the Byurakan interferometer will

make it possible to resolve discrete sources of radio energy from extra-galactic sources far beyond those presently known. Grating interferometers using parabolic dishes larger than 30 feet are being constructed at Riga and Alma-Ata. Scaled-up versions of the Pulkovo antenna are being planned for construction at Kislovodsk in the Caucasus. The Soviets have not built steerable dishes greater than 72 feet in diameter. However, a 120-foot steerable dish has been developed at the Heinrich Hertz Institute in East Berlin. These dishes are not comparable in size to those that are operational or under construction in the West, but they do exhibit very careful research, development, and construction.

The Soviets have developed radioastronomy antennas that are suitable both for tracking missiles and satellites and for use in research associated with electronic aspects of defensive and offensive weapons systems. A few reports on space tracking have been published. The fact that most radioastronomy observatories are located along the western and southern borders of the USSR, with a heavy concentration near missile and satellite launching areas in the vicinity of the Caspian Sea (see map), tends to confirm such use. There is, however, a large area in the Soviet Union in which no sites have a dual purpose, other sites employing radioastronomy antennas probably complete a network covering all areas of the Soviet Union. In possible support of this conjecture, some of the large antennas at the antimissile-associated complex in the Sary Shagan area are similar to those at Soviet radioastronomy observatories.

A Radiophysics and Electronics Institute of the Armenian Academy of Sciences has been created to solve problems of radipphysics and super long-distance communications in association with the large interferometer antenna being developed at Byurakan Astrophysical Observatory. Reports in Pravda on the February 1961 Venus space probe commented on the "giant antennas" associated with a "cosmic communications center" in the USSR. In June 1961, Soviet scientists visiting in England and associated with the probe effort described a large array in the Crimea consisting of eight 50-foot dishes used to receive the signals. Space communications and tracking research, with respect

to the Lunik II probe (which impacted on the moon in September 1959), took place at the Crimean Radioastronomy Station with two large antennas used as an interferometer.

Thus, the basic research on large antenna reflectors and arrays, when associated with active or passive radioastronomy, could support the military posture of the Soviet Union, particularly the antiballistic missile programs. The larger antennas would also be useful to support research on intercept techniques to detect radar and radio emissions in the entire radio-frequency portion of the electromegnetic spectrum. They might also be used to detect nuclear explosions. (SECRET/NOFORN/[redacted]

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